Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Location-Based Routing	)	PS Docket No. 18-64
For Wireless 911 Calls	)	

To: The Commission

COMMENTS OF
THE BOULDER REGIONAL EMERGENCY TELEPHONE SERVICE AUTHORITY

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Summary

The Notice of Inquiry addresses issues which have long concerned BRETSA. Many more calls involve misrouting of 9-1-1 calls based on Phase I (cell site or sector) information ("Phase I Misroutes") than involve callers who do not know or cannot communicate their location to a dispatcher. Yet industry and the Commission have pursued and significant resources have been expended on improved indoor location technology than on addressing Phase I Misroutes.

Phase I Misroutes specifically involve situations where the wireless caller and the cell site through which the call is placed are in the jurisdictions of different PSAPs. However VoIP calls are also subject to being misrouted to the wrong PSAP. Consumer/individual VoIP services, VoIP-based Enterprise Communications Services and nomadic VoIP services are all subject to having 9-1-1 calls routed to the wrong PSAP, though for different reasons. The misrouting of 9-1-1 calls to the wrong PSAP can significantly delay dispatch of First Responders, and can delay dispatch of First Responders longer than solutions such as holding a call until the correct PSAP can be identified.

There are a number of measures which can and should be taken to remedy Phase I Misroutes of wireless calls. The first two are for wireless providers to consider jurisdictional boundaries in siting and cell sectorization decisions, and for providers to evaluate available data to determine which existing cell sites produce a high percentage of Phase I Misroutes. For sites identified to have a high percentage of misroutes, remedies are available and should be considered in consultation with PSAPs from (i) flagging for dispatchers calls from cell sites or sectors with high percentages of Phase I Misroutes, and low percentages of misroutes, (ii) modifying orientation of cell sectors, to implementing Phase II Routing or "Phase III Routing:"

routing calls based on a location technology which is more granular than Phase I Routing and can provide a TTFF of five-seconds or less.

The 9-1-1 system and services must accommodate a variety of location technologies which are suitable to different environments, or may be developed in the future. A 9-1-1 location technology should be secure, reliable and provide data in a format consistent with other location technologies. BRETSA raises the prospect of terrestrial GPS signals embedded in high power broadcast signals capable of penetrating buildings, or special purpose beacons. These terrestrial GPS signals would allow WiFi, Bluetooth or BLE access points or beacons to determine their coordinates and signal timing requirements, and in turn provide GPS signals to devices located in indoor locations. This would require Commission requirements or authorizations of the terrestrial GPS transmitters, as well as of devices which would utilize these signals to become GPS transmitters themselves.

A benefit of the terrestrial GPS transmitter method discussed above is that it would also provide location information for VoIP devices to automatically report their location with 9-1-1 calls. Development of the components for incorporation in such a broad array of devices should serve to limit the impact on unit prices.

Finally, BRETSA remains concerned with the use of dispatchable locations or addresses when the resolution of the location technology cannot, in fact, isolate the location of the caller to a specific structure or building. Providing the locations as dispatchable addresses rather than geographic coordinates with uncertainty information can only cause confusion, rather than allowing dispatchers to use PSAP information systems, information from callers, and their "local knowledge" to pass on to First Responders an accurate picture of the uncertainty as to the caller's

or location incident and the most likely location of the caller or incident based upon the dispatcher's informed assessment.

Table of Contents

Page

Summary. i

Table of Contents. iv

I. Introduction. 1

A. Causes of 9-1-1 Call Misroutes. 2

B. Phase I Misroutes Delay Emergency Response. 4

II. Approach to Remedying Phase I Misroutes. 8

A. CMRS Network Design. 8

B. Identification Of Sites Which Produce A High Percentage Of Phase I Misroutes. 9

C. Remedial Measures For Sites With High Percentages Of 9-1-1 Misroutes. 10

III. The 9-1-1 System Must Accommodate Different Location Technologies. 12

A. Wireless Location Challenges. 13

B. Public Safety Concerns With Wireless Location Solutions. 15

IV. Location Information for VoIP Calls. 18

V. Role of Commission In Implementing Location-Based Routing. 18

VI. Concerns With "Dispatchable Locations." 20

VII. Conclusion. 21

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The Boulder Regional Emergency Telephone Service Authority ("BRETSA"),[1] by its attorney, hereby submits its Reply Comments on the Commission's March 22, 2018 Notice of Inquiry in the above-referenced matter.

I. Introduction.

BRETSA is pleased the Commission has finally opened a docket to address location-based routing of wireless (and VoIP) calls. BRETSA argued in Docket No. 07-114, Wireless E911 Location Accuracy Requirements, that 9-1-1 caller location information for call routing is a higher priority than accurate indoor location information.[2] BRETSA also requested that Public Safety and Homeland Security Bureau Chief Simpson refer the issue of Phase I Misroutes[3] of

[1] BRETSA is a Colorado 9-1-1 Authority which establishes, collects and distributes the Colorado Emergency Telephone Surcharge to fund 9-1-1 service in Boulder County, Colorado.

[2] *Comments Of The Boulder Regional Emergency Telephone Service Authority On Third Further Notice Of Proposed Rulemaking*, PS Docket No. 07-114 (filed May 12, 2014) pp 2-13 ("9-1-1 Caller Location Information For Call Routing Is A Higher Priority Than Accurate Indoor Location Information"). *Reply Comments Of The Boulder Regional Emergency Telephone Service Authority On Third Further Notice Of Proposed Rulemaking*, PS Docket No. 07-114 (filed July 14, 2014) pp 6-7 ("Phase II Routing Is A Higher Priority Than Improved Indoor Accuracy"). *Boulder Emergency Telephone Service Authority Petition for Reconsideration of the Fourth Report and Order*, PS Docket No. 07-114 (filed April 3, 2015) pp 1-6 ("The Rules Do Not Reflect The Way Automatic Location Information Is Used In 9-1-1 Service And Emergency Response").

[3] Routing of 9-1-1 calls to a PSAP other than one which can dispatch First Responders to the caller's location due to routing based on the location of a cell site in a different jurisdiction than that in which the caller is located.

9-1-1 calls (and several other issues pertaining to 9-1-1 Service) to CSRIC or the Commission's Office of Engineering and Technology for consideration.[4]

Misrouting of 9-1-1 calls can occur with wireless and VoIP services. Wireless calls now account for 70% to 90% of all 9-1-1 calls and misroutes of wireless 9-1-1 calls are of greatest concern. However solutions for 9-1-1 call misroutes would ideally have applications for reducing the instance of VoIP 9-1-1 call misroutes.

A. Causes of 9-1-1 Call Misroutes.

Misrouting of 9-1-1 calls is a much larger problem with wireless calls than VoIP or traditional wireline calls because (i) wireless calls are routed based upon the location (and sector) of a cell site which may have a service area miles in diameter and extending into multiple jurisdictions "Phase I Routing," and (ii) wireless 9-1-1 calls generally constitute 70% to 90% of 9-1-1 calls received by PSAPs. 9-1-1 Calls received through a single cell site, or sector of a cell site, can only be default routed to a single PSAP based on the cell site or sector location, even where the cell site or sector serves multiple jurisdictions (or PSAP service areas). When a 9-1-1 Call from a jurisdiction other than the jurisdiction served by the PSAP to which the call is Phase I Routed is received, a Phase I Misroute occurs.

BRETSA reported in its February 23, 2016 letter to Bureau Chief Simpson that:

> BRETSA's Longmont PSAP reports that it receives approximately five Phase I Misroutes per dispatcher per shift, but only about one call per week from an individual who doesn't respond or doesn't know his location. Thus, while cases in which the caller is unable to provide his or her location are rather rare, Phase I Misroutes are quite common.

[4] *See, e.g.*, February 23, 2016 Letter from Joseph P. Benkert, Counsel for BRETSA, to Adm. David Simpson (ret.), Chief, Public Safety and Homeland Security Bureau, pp 7-11. (Other issues raised by BRETSA for consideration by a technical organization are (i) location of non-911 callers via their cellphone locations, such as suicidal, memory-impaired or developmentally-impaired individuals, and (ii) 9-1-1 coverage area (availability) impacts of a transition from SMS text-to-911 service to a session-based text-to-911 service such as emulated SMS text or Real Time Text apparently requiring persistent connections.)

February 23, 2016 Letter from Joseph P. Benkert, Counsel for BRETSA, to Adm. David Simpson (ret.), Chief, Public Safety and Homeland Security Bureau, at 7.[5] BRETSA is aware that there are some jurisdictions which have very few wireless (Phase I) misroutes. These are jurisdictions which do not have significant developed areas or major highways near or along their borders with neighboring counties. In other areas, cell site or sector coverage areas may include multiple jurisdictions and 9-1-1 calls may be transferred more than once before reaching the appropriate PSAP.

Traditional wireline telephone service was installed at each individual premises by a technician employed by the provider, and the assigned telephone number and civic address entered into the 9-1-1 Selective Router (call routing) and 9-1-1 ANI/ALI databases when service was installed. The services and the wireline facilities were provided by the same provider, and could not be used at any other location. VoIP services which have largely replaced business and consumer wireline services in many areas, are not necessarily supplied by the provider of the underlying digital broadband (or narrowband digital) connection. VoIP CPE can be connected by independent VoIP service or CPE vendors or even user-connected, without the broadband provider's knowledge. Some VoIP CPE and services can be relocated by the customer without the broadband, VoIP or CPE providers' knowledge. Enterprise Communications Systems ("ECS") may connect VoIP phones within a large building, a campus or even offices located in different cities, counties or states through a single "digital PBX." Currently, VoIP 9-1-1 calls are routed based on location information provided to their VoIP service provider, generally without verification. Nomadic VoIP services and fixed VoIP service which can be relocated without the user updating location information, can also result in misroutes.

[5] Since the date of that letter, the Longmont PSAP has seen a decrease in the number of Phase I Misroutes, while other BRETSA PSAPs have not noted any change. This could be the result of wireless providers sectorizing a cell site, or replacing/augmenting a site with additional sites with smaller coverage areas to increase system capacity.

B. Phase I Misroutes Delay Emergency Response.

Typically, only the PSAP(s) serving the jurisdiction in which a 9-1-1 caller is located has the (i) authority, (ii) access to First Responder availability, location and business rules for response,[6] (iii) dispatch radio systems and channels, and (iv) clear protections of governmental immunity to dispatch First Responders to an incident.

Only the PSAP serving the jurisdiction in which the caller is located will have records and information systems for the jurisdiction, including various types of maps of the jurisdiction with multiple layers providing a variety of data useful in processing the call and dispatching First Responders. This data may include aerial photographs and pictometry of the jurisdiction, current information regarding road closures and even real-time data from Department of Transportation traffic monitors for use in First Responder routing to the scene of the incident, premises records and flags regarding previous incidents or other potentially critical information regarding the location of the incident. The cost of licenses for such information, and the data storage systems, and information systems to maintain and use the data, makes it impractical for PSAPs to maintain data for jurisdictions other than their own (although PSAPs may maintain data extending some distance beyond their jurisdictional boundaries).

PSAP personnel are required to be familiar with municipal or county ordinances and regulations as well as state laws which may dictate the type of response (e.g., dispatch First Responders on an emergency basis, dispatch First Responders or civilian volunteers on a non-priority basis to take a report, have the person visit a police station or substation to make a report, etc.) There is a limit to the number of different codes and business rules a dispatcher can reasonable retain, and thus the number of jurisdictions and agencies she or he can dispatch

[6] For example, a First Responder Agency's business rules specify the number and types of units to respond to a particular type of incident.

without having to take the time to access reference information. “Local knowledge” of PSAP personnel regarding “trouble spots,” recent calls regarding a particular location or individuals, landmarks and other information a caller may give to confirm their location, regular subjects of 9-1-1 calls and even familiarity with the First Responders they dispatch, is also important.

When a PSAP receives a misrouted 9-1-1 call, the PSAP will generally have to determine that the call has been misrouted, identify the jurisdiction in which the caller is located, and transfer the call to the PSAP serving that jurisdiction or area. Even assuming that the caller knows where he or she is located, such as the mile marker on an Interstate highway, he may not know which city or county he or she is in which would be critical to knowing which PSAP can handle the call. A dispatcher may not know that the caller is located in another jurisdiction until the more accurate Phase II wireless location information is received.

When a call arrives, the first two questions asked by the dispatcher will generally be “What’s the nature of your emergency?” and “What’s your location?” (The order and specific wording of these questions may change, but they are typically the first questions asked.) This information may alert the dispatcher that the call has been misrouted. For example, 9-1-1 calls from Interstate 25 are sometimes routed to the Longmont, Colorado PSAP, even though the highway is well outside Boulder County and the Longmont PSAP’s jurisdiction. However the caller-provided location often will not initially advise the dispatcher that the caller is located outside the PSAP’s jurisdiction.

The dispatcher will proceed to ask the appropriate questions based upon the nature of the emergency, and attempt confirm information provided including the location of the caller. Information must be confirmed because people who are upset by the situation in which they find

themselves may innocently provide incorrect information.[7] The dispatcher will be entering the data into a CAD record file, may dispatch First Responders, and may begin providing EMD (following a script of diagnostic questions and first aid instructions) while waiting for the Phase II Location data to arrive. In PSAPs without CAD or phone systems which automatically rebid for caller location information, the dispatcher will often be repeatedly hitting the rebid key until the Phase II data is received.

As stated, if the 9-1-1 call has been misrouted, the dispatcher will have to determine the correct PSAP which should receive the call. This is not always a simple task. Once the appropriate PSAP to handle the call is determined, PSAPs in Colorado and many other states use two-digit transfer codes to forward 9-1-1 calls to the PSAP through the 9-1-1 system so that the Phase II location information will also be available to that PSAP. Once the call is transferred to the correct PSAP, a dispatcher at that PSAP must start all over interviewing the caller to identify and confirm the nature and location of the emergency before First Responders can be dispatched.[8] Thus, the time required to identify the call as Phase I Misroute and transfer the call, the time required to identify the correct PSAP to receive the call, and the time for the dispatcher at the correct PSAP to determine and confirm the nature and location of the emergency and the

[7] BRETSA submitted a transcript of a 9-1-1 call at Exhibit No. 1 to its April 4, 2014 comments on the Commission's January 31, 2014 Policy Statement and Second Further Notice of Proposed Rulemaking in Docket No. 11-153, available at http://apps.fcc.gov/ecfs/document/view?id=7521096988 and the audio recording of that call, "Suicide By Semi" is available at: http://911colorado.org/911-audio-videos/other-911-calls/ or https://www.youtube.com/watch?feature=player_embedded&v=XeK_1PjoKzo. The transcript was initially submitted in support of a November 21, 3012 Petition for Rulemaking filed by BRETSA pertaining to the systems by which locations of individuals other than a caller are provided by CMRS providers in emergencies. The transcript still provides an example of the manner in which calls are handled, callers inadvertently provide incorrect information, and questions are re-asked and information verified so the appropriate response can be provided.

[8] BRETSA believes that one of the most important but generally overlooked functionalities of NG9-1-1 will be the ability to transfer the CAD incident record created at the first PSAP along with the transfer of a misrouted 9-1-1 call (although xml coding of CAD database fields or other translation tables may be a prerequisite for transfer of such incident records). If the nature and location of the emergency has been determined and confirmed by the first PSAP, the CAD system at the PSAP to which the call is transferred could recommend units for dispatch or automatically dispatch First Responders according to agency business rules before the dispatcher at the second PSAP has begun interviewing the caller.

First Responders to dispatch, can delay dispatch and arrival on-scene of First Responders *by several minutes*.

CSRIC V WG1 found that most currently deployed 9-1-1 location technologies require an average of 15 to 23 seconds to calculate an E9-1-1 Phase II location fix, and the Commission's rules allow up to 30 seconds for wireless service providers to provide a Phase II fix.[9] However with 9-1-1 calls using from handset-based technologies (GPS) to provide a location, individuals in areas with heavy tree cover, in natural or "concrete" canyons, or in building interiors it may take longer to obtain a Phase II location fix, if ever.[10] However delays in connection of 9-1-1 calls to PSAPs can result in callers hanging-up and re-dialing the call. CSRIC V, WG1, Task 2 Report, §7.1, "Cons" item 2.

Delays in delivery of 9-1-1 calls to the correct PSAP, and delivery of sufficiently granular incident location information for dispatch when the person does not know their location or is incapable of communicating his or her location, are critical. A person who has a major artery severed can bleed to death within minutes, Brain cells start dying after just 5 minutes without sufficient oxygen, such as from smoke inhalation, carbon monoxide poisoning, heart attack, choking, drowning, drug overdose, or stroke. After 6 minutes brain damage becomes very likely, and after 10 minutes without sufficient oxygen brain damage becomes irreversible. During a heart attack, blood flow to the heart may be stopped causing portions of the heart muscle to be irreversibly damaged or die. Fire can spread and fully engulf a house within minutes and begin to spread to other structures.

[9] Communications Security, Reliability and Interoperability Council V, Working Group 1, Evolving 911 Services, Final Report – Task 2: 911 Location-Based Routing (Sep. 2016), at 8 ("CSRIC V, WG1, Task 2 Report").
[10] As previously noted, the increase in cases in which *no* Phase II information is provided appeared to coincide with the increased use of handset-based Phase II location solutions relying upon GPS for location determination, and may be related to unavailability of GPS signals at indoor locations and other locations where receipt of GPS signals may be limited. *Comments Of The Boulder Regional Emergency Telephone Service Authority On Third Further Notice Of Proposed Rulemaking*, PS Docket No. 07-114 (filed May 12, 2014) pp 8-9.

Except in egregious situations, it may be difficult to assign the death of a person or a worse outcome to a person to delay in receipt of a 9-1-1 call at the appropriate PSAP. Outcomes will be affected by a number of factors including (i) the condition of the subject before the incident, (ii) the nature and severity of the incident (e.g., the severity of the subject's injuries or condition as a result of the incident), (iii) the time that elapsed prior to someone calling 9-1-1, (iv) whether someone present on-scene intervened to provide First Aid or take other responsive action—for better or worse—prior to arrival of First Responders, (v) the time required for the 9-1-1 call to be processed and First Responders dispatched, (vi) the time required for First Responders to arrive on scene (which could be impacted by the location of the incident in relation to the location of First Responders, traffic, weather, inaccurate location information or difficulty locating the subject within a building, for example, or other conditions), (vii) in some cases the time required for transport to a hospital, (viii) the availability, training and skill of medical personnel, and (ix) perhaps characteristics personal to the subject. Nevertheless, it cannot be gainsaid that delays of one to several minutes before First Responders are dispatched due to 9-1-1 misroutes affect outcomes.

II. Approach to Remedying Phase I Misroutes.

BRETSA has identified a number of methods of reducing the incidence of Phase I Misroutes. Some methods may also be relevant to location-based routing even after NG9-1-1 is fully deployed, including geospatial routing.

A. CMRS Network Design.

CMRS systems have been licensed and built out on a regional basis, commencing approximately a decade before the Commission began applying 9-1-1 requirements to CMRS services. CMRS systems were originally built out with cell sites serving large areas covering

multiple local jurisdictions served by separate PSAPs. As CMRS systems have been built out, it does not appear any consideration has been given in system and site design to minimizing the opportunities for Phase I Misroutes.

As CMRS providers continue to sectorize cell sites to allow greater frequency reuse and increase system capacity, and large cell sites are replaced with smaller cell sites for the same purpose; the Commission should require that CMRS providers consider PSAP jurisdiction boundaries in system design.

It is clear that CMRS system and cell site design cannot eliminate all Phase I Misroutes. Radio frequency transmission characteristics together with the size and boundaries of PSAP jurisdictions make impossible and impracticable the limitation of coverage of cell sites to a single PSAP's jurisdiction; and that is not what BRETSA is proposing. BRETSA does not propose that CMRS providers be required to incur any expense in constructing additional facilities or new transmission sites to constrain site coverage to a single jurisdiction. BRETSA is only proposing here that when a CMRS provider is sectorizing a site or selecting and building a new site to provide new coverage or increase system capacity, it consider PSAP jurisdictional boundaries and consider the minimization of Phase I Misroutes in the location of its sites and orientation of cell sectors.

B. Identification Of Sites Which Produce A High Percentage Of Phase I Misroutes.

Other potential solutions should start with identification of cell sites which produce a high percentage of Phase I Misroutes. As stated above, there are PSAP jurisdictions (counties) in Colorado which have very few Phase I Misroutes. BRETSA believes there are cell sites within its and other jurisdictions in Colorado (and other states) which are not located near jurisdictional boundaries and which produce few if any Phase I Misroutes. Other cell sites located near

jurisdictional boundaries, however, appear to produce significant numbers of Phase I Misroutes. Consider the experience of the Longmont, Colorado PSAP in receiving a notable number of 9-1-1 calls relating to traffic accidents on I-25, which passes adjacent to Boulder County but not through Boulder County.

BRETSA is not certain of the data available to and retained by CMRS providers, SSPs, and ANI/ALI providers which can be used to identify CMRS sites which are responsible for Phase I Misroutes. However between these entities and PSAPs, there should be data which can be captured and analyzed to identify cell sites or sectors which are responsible for Phase I Misroutes, and to rank them according to the number or percentage of Phase I Misroutes within a given period of time. These sites can then be evaluated over time by the CMRS providers for remedial action, starting with the sites which are responsible for the largest number of Phase I Misroutes.

BRETSA notes that while it can be expected that in more urbanized areas cell sites may be sectorized and replaced with smaller sites to enable greater levels of frequency re-use and increase system capacity, even smaller sites near jurisdictional boundaries will produce 9-1-1 Phase I Misroutes, and in less urban areas cell sites will continue to serve larger areas, in some cases spanning jurisdictional boundaries. BRETSA also notes that CSRIC V found that "[t]o-date, no location method, other than Cell ID, has proven reliable enough and quick enough to be relied upon for routing 9-1-1 calls to the appropriate PSAP." CSRIC V, WG1, Task 2 Report, at 27.

C. Remedial Measures For Sites With High Percentages Of 9-1-1 Misroutes.

A cell site or sector should never have more than 50% of 9-1-1 calls misrouted based on Phase I information. If it does, then it is configured to route 9-1-1 calls to the wrong PSAP. The range of percentages and numbers of Phase I Misroutes from cell sites and sectors is not known.

This information, as well as identification of sites to be initially targeted for evaluation for remediation is critical will be simultaneously identified.

Measures which can be taken to mitigate or Phase I Misroutes from *existing* sites include (i) modifying default routing for sites or sectors which may route to the wrong PSAP, (ii) identifying to the PSAP calls routed from sites which have varying percentages of misroutes, to alert dispatchers to calls which may be Phase I Misroutes, (iii) sectorization of the cell sites to limit the coverage of multiple jurisdictions by a single system antenna, (iv) re-orientation of system antenna and cell sectors to limit the coverage of multiple jurisdictions by a single system antenna, (v) delaying routing of 9-1-1 calls until Phase II information is received (a solution discouraged by CSRIC V, WG1), (vi) implementation of a faster Phase II location determination technology/development and implementation of a "Phase III" location determination technology which would provide (i) greater location resolution than Phase I cell site or sector default routing, (ii) more rapidly than Phase II location information can currently be provided.

While CSRIC V, WG1 found that delaying routing of 9-1-1 calls until Phase II information is received can result in callers hanging-up and re-dialing 9-1-1 if presented with "dead air," there are measures that can be taken to address this. It has been reported that the implementation of SS7 had a benefit of eliminating cases where callers to 9-1-1 would hang-up when encountering "dead-air" and attempt to immediately redial (sometimes having second and subsequent calls blocked by the previous calls and lines which had not yet been released). Reportedly, because SS7 performed signaling and call set-up out-of-band, the caller would hear a ringing tone rather than "dead air" during call setup. Whether this is urban legend or true, it should be possible with modern devices and systems to play back to the 9-1-1 caller a ringing sound until Phase II information is received or a time-out period expires and the call is routed

based upon Phase I information. Again, BRETSA proposes this solution be implemented for 9-1-1 calls received through sites or sectors with high percentages of Phase I Misroutes.

With respect to implementation of a faster Phase II location determination technology, or development and implementation of a "Phase III" location determination technology which would provide (i) greater location resolution than Phase I cell site or sector default routing, (ii) more rapidly than Phase II location information can currently be provided; the Commission has not sought such a solution. NextNav, a participant in the CSRIC III indoor location accuracy testing, represented that its location technology could provide a time-to-first-fix ("TTFF") within six-seconds from a cold start. The technology also turned in impressive location accuracy results in the CSRIC III tests. When BRETSA inquired of NextNav as to why the CSRIC III test results did not demonstrate the claimed *TTFF* performance, NextNav responded that the purpose of the CSRIC III tests was to assess the accuracy of location fixes which could be produced within 30-seconds, and it was therefore to NextNav's advantage to take the entire 30-seconds allotted to assure provision of the most accurate locations possible. To identify technologies which can provide a TTFF of within five-seconds or less, as CSRIC V stated would be required for routing purposes, with more granular locations than Phase I data; testing must be performed for *those* capabilities of location technologies.

III. The 9-1-1 System Must Accommodate Different Location Technologies.

Wireless location technologies rely upon (i) signal attenuation or time required for radio signals to travel between transmit and receive locations to determine distance of a device from known locations, (ii) direction from which a signal is received from a device at known locations, (iii) proximity to radio beacons of known locations, and (iv) mapping characteristics of received signals (location signatures), such as multipath profiles. Hybrid solutions employ multiple

location technologies. With some technology applications, location may be determined by the user's handset, while location is determined at the network level by others. The same location technology may be used both on a broad level, such as GPS, and on a very small level such as for tracking customers within a retail store.[11] Some location solutions provide the geographic coordinates of the user device, dispatchable location provides the civic address at or near which the user device is located, and retailer systems provide location on a custom grid of the retailer's floor plan. It is also possible that two or more different, even coarse, location solutions employed simultaneously would in the aggregate supply a location more accurate than any one of the solutions could provide.

A. Wireless Location Challenges.

Wireless location technologies and applications face challenges of one type or another, to varying degrees. These challenges include terrain blocking of radio signals, and limited ability of signals to penetrate buildings or "concrete canyons," and heavily vegetated areas. Even where signals are receivable, they may be attenuated more than expected, or receipt of reflected or diffracted signals may be sufficiently delayed to affect location accuracy.

Locations solutions may be expensive to implement and maintain, and may be impacted by construction or other environmental changes, relocation or replacement of privately-owned WiFi Access Points, Bluetooth or BLE Access Points or beacons, or implementation of privacy or security measures. Some technologies and solutions may be proprietary. It is not clear to BRETSA that all over-the-top, WiFi or Bluetooth/BLE solutions will be available for handset- or network-based use with 9-1-1 calls, or that device hardware/firmware or network based solutions will be available for WiFi 9-1-1 calling. There may be an adequate density of privately owned

[11] Much of the development of location solutions today appears to be in the retail environment, to allow retailers to track and design patron traffic flow, deliver to patrons product information or coupons for products located at the point in the aisle where the customer is browsing, etc.

and deployed WiFi, Bluetooth and BLE access points and beacons in urbanized areas to provide reliable location services, but there are suburban and vast rural areas where such density will never be reached.

To the extent location information must be input into WiFi, Bluetooth or BLE access points or beacons, or end-user placed femtocells or cellular signal boosters; the end-users cannot be relied upon to undertake entry of the information, enter the information correctly, or update the information if the devices are relocated. These types of failures will not only impact the accuracy of location data, but require continued commercial (including crowd-sourced) efforts to keep databases current and accurate. Ability (indeed the requirement) that users input location information also raises security issues, such as the potential for users to spoof their location for nefarious purposes. The lack of certainty as to location or permanence of position of such devices within many end user's premises would also appear to limit the precision of location fixes based upon them. With most of these location technologies, accuracy improves over time.

Limitations in battery technology and the power draw of GPS chips and location applications inhibit customers from keeping location services turned on in their phones when not required for a specific purpose. This means that GPS chips activated automatically upon a user calling 9-1-1 would be operating from a "cold start," delaying obtaining an accurate location fix (although A-GPS can help), or users would have to remember to turn on location applications prior to calling 9-1-1 on an over-the-top VoIP application or using some other over-the-top method to contact 9-1-1. However motor vehicles equipped with GPS and connected to a user's cell phone by Bluetooth faces no such battery limitations.

Because no single location solution will be effective or cost-effective in all environments, 9-1-1 systems must be capable of accommodating and utilizing location data provided by different location solutions, including future location technologies.

B. Public Safety Concerns With Wireless Location Solutions.

BRETSA has been concerned that the Commission has focused on a solution for more accurate indoor location information for devices used to call 9-1-1, than more accurate call routing when more people are impacted by Phase I Misroutes than by inaccurate location information. Phase I Misroutes far outnumber 9-1-1 calls involving a caller whose location is not sufficiently identified *and* cannot tell the dispatcher his or her location. Further, not all of these calls will involve a medical or similar emergency in which First Responders could reach the caller's location in time to make a difference but for the lack of location information. First Responder agencies must prioritize application of limited resources to the benefit of the most people.

As discussed at Section VI below, notwithstanding the colorful language used by some commenters about providing First Responders "Dispatchable Locations" so they 'know the right door to kick in;' it does not appear that the indoor location standards adopted by the Commission will provide First Responders sufficiently accurate information to assure they do 'kick-in the right door.'

Similarly, with recent developments such as "Swatting" and anti-police violence, it is important that location information not be susceptible to spoofing. To prevent spoofing, location information in WiFi, Bluetooth and BLE access points and beacons would not be user-alterable, and would have to be automatically set, and modified upon relocation of devices.

Location data from different location technologies and solutions should be presented to PSAPs in a single format. As discussed in Section VI below, BRETSA believes this should be geographic coordinates. There will be a degree of uncertainty or error in any location information. This plot of the geographic coordinates as or with a circle identifying the accuracy or resolution of the plot, and elevation information when available, should be presented to the dispatcher. The dispatcher can take into account the same factors data systems would in assigning the caller location to a dispatchable location such as the address/location of a WiFi AP used to determine the caller's location, *and can also take into account such factors as background noise heard over the caller's phone, information provided by a caller who doesn't know his location but can describe his surroundings, prior incidents and premises flags at locations within the uncertainty area, and "local knowledge."*

WiFi, Bluetooth and BLE AP and beacon location information cannot be reliably set using satellite-based GPS alone, because such GPS signals are not sufficiently strong to penetrate many structures in which such devices are located. The solution may be to use stronger *terrestrial* GPS transmitters capable of penetrating buildings, even where cellular telephone signals cannot. This might consist of FM radio and/or Television signals transmitting transmitter IDs or transmitter site coordinates and the timing signals embedded within their primary signals or within their allotted bandwidth; which WiFi, Bluetooth or BLE APs and beacons can use to determine their locations. Alternatively, special purpose beacons transmitting signals capable of penetrating buildings in urban environments might be deployed, preferably funded on a commercial basis to support retail installations, to enable WiFi, Bluetooth or BLE APs and beacons to determine their locations. The wireless AP and Beacon devices would in turn transmit

their geographic coordinates and timing signals at specific intervals, to allow mobile phones and other mobile devices to, in turn, determine their locations.

Whether capable of determining their locations from the data transmitted or relying on Internet connections to allow for network processing of location data, the AP and beacon devices would only need to be capable of receiving signals from the terrestrial- and/or satellite-based GPS systems. This would minimize the additional costs for such location-aware devices. Accuracy of location should improve over time, and the devices should also be aware of when they are relocated and need to re-acquire a location fix. The means of acquiring location data for use in 9-1-1 call routing or locating the caller would be (i) beyond the control of most users (secure and reliable), (ii) uniformly incorporated in the WiFi, Bluetooth and BLE APs and beacons, WiFi, Bluetooth and BLE devices and other wireless devices and likely less expensive due to its uniformity, and allow standardized processing and use of the location data. This would not prevent a manufacturer or vendor of WiFi, Bluetooth or BLE APs and beacons including commercial (retail) location systems from incorporating capabilities to provide alternative location data, such as grid systems customized to retail establishments.

The main challenge to such a solution dependent on terrestrial GPS transmitters with signal strengths capable of penetrating buildings, is the embedded base of CPE. However as new devices are developed and marketed with greater data speeds and new features, CPE will be replaced. Long term solutions are essential when there are no practicable short-term solutions, or they may be implemented alongside short term solutions.

The security aspects of such solutions would not necessarily attach to over-the-top VoIP or 9-1-1 applications. The attendant loss of accuracy and reliability would also not necessarily attach to over-the-top applications. The solution may be to enable over-the-top applications to

access the location information provided for 9-1-1 purposes, or to provide for interconnected over-the-top systems to comply with 9-1-1 requirements by enabling them to access a wireless handset's native telephone functionality in the case of 9-1-1 calls.

IV. Location Information for VoIP Calls.

9-1-1 location information for routing and response to VoIP 9-1-1 calls is provided by the VoIP service user supplying his or her address to the VoIP provider. The VoIP provider must update this location information if he or she moves and uses the VoIP service at another location. Nomadic VoIP also poses challenges for 9-1-1 location data.

A solution suggested for indoor location of CMRS devices, relying on terrestrial GPS transmitters capable of penetrating building even in urban environments, would also seem to provide a solution for VoIP devices. The security aspects of implementing such solutions would not necessarily attach to over-the-top applications. As discussed above, over-the-top applications running on CMRS devices could be permitted to access device location information for purposes of placing 9-1-1 calls, or to use the CMRS devices native telephone functionality as a means of complying with 9-1-1 requirements.

For VoIP 9-1-1 calling using an over-the-top application installed on a tablet or computer, a hardware-based solution for 9-1-1 calling will generally not exist and cannot be accessed. However with the establishment of a uniform satellite *and terrestrial* GPS system and components for receipt of such location information it is likely such components would ultimately be incorporated even in these devices. It would not development/modification and use of applications capable of spoofing a 9-1-1 caller's location, but it would make it more difficult.

V. Role of Commission In Implementing Location-Based Routing.

Unfortunately, CMRS providers do not have market-based motive for providing efficient and accurate 9-1-1 calling and location information. Despite significant 9-1-1 outages over the

past few years no provider has been shown to have suffered a loss of customers, revenues or share value as a result of such outages. Service providers are also generally provided immunity or limited immunity from liability for 9-1-1 failures under state law. This may be appropriate where there is state regulatory oversight of a provider's handling of 9-1-1 calls, but the carriers have successfully pushed deregulation even of their handling of 9-1-1 calls in many states. Providers further limit State oversight of 9-1-1 service by refusing to provide copies of their filings with the Commission pertaining to 9-1-1 service. This leaves it to Commission regulation to drive maintenance and improvement of wireless and VoIP provider provision of 9-1-1 service (delivery of 9-1-1 calls to an SSP with required location or routing information).

The Commission should require CMRS providers to (i) consider PSAP jurisdiction boundaries in deploying and designing new cell sites and orienting antennas of newly-sectorized sites, and (ii) compile and assess data regarding the percentage of 9-1-1 calls from each cell site and cell sector which are misrouted based upon Phase I information, assess with affected PSAPs means of mitigating or remediating the level of Phase I Misroutes.

The Commission should require testing of call-routing technologies with a primary focus on TTFF, and secondary focus on the accuracy of the fix. Location accuracy for call-routing does not need to be as accurate as for Emergency Response to substantially reduce the percentage of calls which are Phase I Misrouted. This can lead to development or adoption of a Phase II Location technology which would deliver a Phase II location within the time required to route the call to the appropriate PSAP on the basis of the Phase II location, or development of a "Phase III location technology which would deliver a location more accurate than a Phase I location but not meeting the accuracy requirements of a Phase II location, but quickly enough for use in routing the call to the appropriate PSAP.

The Commission should require that 9-1-1 service/systems be capable of accommodating different location technologies, including technologies which have not yet been developed or implemented. (CMRS provider should not be required to incur any expense to implement any specific location technology, thereby creating a mandated market for any technology which may be developed yet offer no improved functionality over existing technologies.)

The Commission should authorize terrestrial GPS transmitters, or require licensed FM and TV broadcast stations to imbed transmission of GPS information in their broadcast signals or allotted bandwidth as part of their public interest obligations. In adopting this solution for indoor location accuracy, and perhaps call-routing, the Commission would also have to adopt WiFi, Bluetooth and BLE AP and beacon requirements, and handset requirements, to utilize terrestrial as well as satellite-based GPS in a secure and reliable manner.

VI. Concerns With "Dispatchable Locations."

In its Comments and Petition for Reconsideration in Docket No. 07-114,[12] BRETSA argued against use of "Dispatchable Locations." There is a history of police actions or arrests at mistaken addresses, in which innocent civilians and police officers have been injured or killed. There is the recent trend of "Swatting," placing prank calls to emergency services in attempt to cause the dispatch of a large number of police officers to a particular address. It's thus surprising that it would be proposed and steps toward implementation of providing civic addresses for 9-1-1 callers using a location technology with a technology location exceeding the side of most residential or commercial structures. Further, the location of a WiFi or Bluetooth device near an

[12] *Comments Of The Boulder Regional Emergency Telephone Service Authority On Third Further Notice Of Proposed Rulemaking,* PS Docket No. 07-114 (filed May 12, 2014) pp 25-27. *Boulder Emergency Telephone Service Authority Petition for Reconsideration of the Fourth Report and Order,* PS Docket No. 07-114 (filed April 3, 2015) pp 13-16.

exterior wall of a structure or unit is as likely to provide a location beacon to an adjacent building, unit or exterior area as within the building or unit.

Assigning a specific address to a wireless 9-1-1 call which may not be placed from that address can only cause confusion, expose First Responders and the public to risks of entering the wrong premises, or place First Responders at risk of ambush (depending upon the type of call).

Providing a dispatcher a plot of the geographic coordinates and uncertainty area would provide the dispatcher the most accurate and complete information of the caller's location available, and allow the dispatcher to use information from the caller, the PSAP information systems and local knowledge to determine the mostly likely location of the caller and incident, and to communicate to the First Responders accurate information regarding the uncertainty and confidence in the information provided.

It is curious that there are those who proposing and promote use of NG9-1-1 to provide dispatchers all manner of information including crash telemetry, medical records, health monitor information, photographs or videos of crime or accident scenes (which can distort reality based on the perspective and focal length used), and expect dispatchers to use this information and not be affected by graphic photographs while also using numerous complex PSAP systems, remembering state and local codes and agency business rules, maintaining situational awareness of other calls and incidents being handled by the PSAP; yet not trust the dispatchers to determine the location of a caller and dispatch First Responders without a dispatchable address or location rather than geographic coordinates.

VII. Conclusion.

BRETSA has repeatedly raised concerns with the misrouting of 9-1-1 calls based upon Phase I wireless location information. Solutions such as considering PSAP jurisdictional boundaries in siting and cell sectorization decisions, evaluating data to identify and remediate

cell sites with high percentages of Phase I Misroutes, flagging calls from sites or sectors with high percentages of Phase I Misroutes (and those with no or low percentages of Phase I Misroutes) for dispatchers, assessing TTFF for location technologies more granular than Phase I data for call routing purposes, even if those technologies are not granular enough to meet Phase II location requirements.

BRETSA has been concerned with the use of Dispatchable Locations notwithstanding that the civic addresses provided may or may not reflect the actual caller's location, notwithstanding the capabilities of dispatchers to evaluate locations and uncertainty areas presented by geographic coordinates. PSAPs have invested considerable amounts of capital, time and effort in developing information systems, dispatchers will be on the phone speaking with the callers, and dispatchers have developed "local knowledge," which can be used to determine the caller's location where the caller cannot definitively provide it. Technology should serve the needs of emergency dispatch and response; emergency dispatch and response should not serve the needs of technology.

Respectfully submitted,

BOULDER REGIONAL EMERGENCY TELEPHONE SERVICE AUTHORITY

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